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Human Capital and Industry Wage Structure in Guatemala

A model of endogenous growth is used to test the effect of education on wage differentials.

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Summary findings

The presence and persistence of substantial wage differentials between industries has been documented. Differences between wages in different industries could result from (1) the normal functioning of competitive labor markets (compensating differential levels of human capital), (2) institutional factors, such as the presence of a union, and (3) efficiency wages paid in some industries (employers finding they can increase profits by paying workers above-market wages).

Using a testable model of endogenous growth, Sakellariou analyzes microdata from the Guatemala Household Survey to estimate the external effects of education.

First, he estimates a wage equation and filters out the internal effects of education. Then, to isolate external effects, he regresses the resulting wage premiums in industry on average human capital as well as on industry-specific characteristics.

Stronger conclusions cannot be drawn, but the analysis does not reject the hypothesis that external effects are present.

This paper — a product of the Education and Social Policy Department — is part of a larger effort in the department to apply economic analysis in the education sector. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Ian Conachy, room S10-022, extension 33669 (17 pages). April 1995.

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HUMAN CAPITAL AND INDUSTRY WAGE STRUCTURE IN GUATEMALA

by

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Introduction

The presence and persistence of substantial wage differentials between industries has been documented in a series of studies (see, for example, Krueger and Summers 1988; Gera and Grenier 1994). Interindustry wage differentials can result from: a) the normal functioning of competitive labor markets (compensating wage differentials or differences in human capital accumulation); b) institutional influences, mainly as a result of the presence (or absence) of a union; and c) efficiency wages paid in some industries; that is, employers finding that they can increase profits by paying workers wages that are above market rate.

In section 2, I briefly discuss the above listed alternative explanations and the possibility of testing these explanations using a Guatemalan microdata set, the 1989 *Encuesta Nacional Socio-Demografica* (ENS 1989). In section 3, Lucas's (1988) hypothesis of the external effects of human capital is tested using a two stage approach: in the first stage, wage functions for individuals are estimated to isolate internal effects of education, while in the second stage industry wage premiums are regressed on industry-specific characteristics and average human capital in each industry in order to isolate any external effects.

Alternative explanations

If interindustry wage differentials are a result of a different mix of skills or job characteristics, then we would expect them to be smaller when a subgroup of workers that is homogeneous in terms of tasks performed is used than when one uses all workers. An obvious way to test the above is to separate the sample into white-collar and blue-collar workers.

Separate wage functions for white and blue-collar workers as well as all workers were estimated[1] and the resulting estimated wage differentials (coefficients of the industry dummies in the wage function) for one-digit industries are given in table 1. The excluded category is agriculture.

The evidence provided goes against the explanation that interindustry wage differentials are, to a large extent, caused by differences in job characteristics. Dispersion of wage differentials for all workers, as measured by the standard deviation of differentials are not lower than the separately estimated differentials for white-collar and blue-collar workers.

A related explanation attributes interindustry wage differentials to differences in patterns of human capital accumulation across industries. Such differences include differences in individual characteristics such as level of educational attainment, age, gender, length of job tenure and firm size (which has been suggested as an important factor in explaining wage differentials (see Brown and Medoff 1989)).

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[1] Weighted least-squares were used. The dependent variable is the logarithm of hourly wages. The explanatory variables include years of schooling and its square, age and its square, two marital status dummies, one ethnicity dummy (indigenous/non-indigenous), one sex dummy, one firm size dummy, one urban/rural dummy, nine occupation dummies and eight (one digit) industry classification dummies.

Table 1: Estimated Wage Differentials for One-digit Industries, Guatemala 1989

	Industry Coefficient		
	All Workers	White Collar	Blue Collar
Mining	0.185	0.292	0.152
	(1.4)	(1.0)	(1.0)
Manufacturing Industry	-0.141	-0.111	-0.142
	(3.9)	(1.5)	(3.5)
Electricity, Gas, Water	0.196	0.235	0.186
	(2.7)	(1.6)	(2.2)
Construction	0.028	-0.089	-0.015
	(0.7)	(0.8)	(0.4)
Commerce	-0.127	0.121	-0.100
	(3.3)	(1.6)	(2.1)
Transportation	0.014	-0.014	0.048
	(0.3)	(0.2)	(0.9)
Finance	0.104	0.130	0.099
	(2.0)	(1.6)	(1.2)
Services	0.028	0.088	-0.043
	(0.8)	(1.3)	(1.2)
Standard Deviation of Differentials	0.126	0.150	0.118
R_2	0.59	0.50	0.42
Sample Size	6,637	1,795	4,842

Source: ENS 1989.
Note: t-statistics in parentheses.

The dispersion of interindustry wage differentials for different types of workers based on separate earnings functions for each type of worker are presented in Table 2. Dispersion is measured by the simple standard deviation of the resulting coefficients (differentials). Alternative samples for unionized/non-unionized workers as well as samples based on length of job tenure could not be obtained because the union and tenure variables are not part of the data set.

The first panel in table 2 consider two age groups, namely, 18-25 and 35-65 years. Dispersion of differentials, measured by the simple standard deviation of differentials, is almost identical. Therefore, differentials do not seem to be the result of older workers sharing larger rents.

The second panel considers two education groups, low (no schooling or primary education) and high (secondary school or university degree). The standard deviation of industry wage differentials for the low education group is more than twice that of the high education group. If, however, one outlier is omitted when calculating the standard deviation for the low education group, the difference in standard deviations narrows significantly, but a considerable difference still remains.

Since the dispersion is greater for employees with less specific human capital, interindustry wage differentials do not appear to be the result of more educated workers sharing a larger rent.

Table 2: Alternative Samples and Estimated Wage Differentials

	Standard Deviation	Sample Size
Age		
18-25	0.179	2,133
35-65	0.187	2,645
Education		
Low	0.342	4,742
High	0.149	1,896
(One industry outlier omitted)		
Low	0.202	4,742
High	0.149	1,896
Sex		
Males	0.157	4,908
Females	0.350	1,730
Firm Size		
> 10 employees	0.162	4,224
< 10 employees	0.300	2,414

Source: ENS 1989.

a. 21 Industry dummies were derived by combining the one-digit industry variable and the occupation variable. While agriculture and mining are taken as homogeneous groups, employees in other industries are divided in more homogeneous groups, i.e., manual versus non-manual workers and when sample sizes permit professionals, administrators, office workers etc., within each industry.

Dispersion of wage differentials based on gender and firm size are substantial. Here, one would expect that dispersion would be greater for male employees and employees of larger firms. However, the data indicate otherwise, possibly suggesting that there is more arbitrariness in wage determination for females and employees of small firms.

Certain explanations of interindustry wage differentials could not be tested, as crucial variables are not part of the data set. In particular, differentials may reflect "compensating" differentials, the testing of which would require information on risk of injury and other health hazards, non-standard weekly hours, or at least full-time versus part-time work.

Likewise, we cannot test an explanation which suggests (unmeasured) labor quality differences as a cause of wage differentials. Here, one needs longitudinal data to control for time-invariant unmeasured labor quality, possibly by estimating interindustry wage differentials estimated for a sample of industry changers and comparing them to those for a cross-section of workers.

Institutional explanations stress the extent of unionization across industries as a cause of wage differentials. If unions can raise wages in certain industries without suffering serious employment loss, this can lead to higher dispersion of differentials among unionized industries. The absence of information on unionization in the Guatemalan data set did not allow testing of this hypothesis. Results obtained by Krueger and Summers (1988) using United States data and Gera and Grenier (1994) using Canadian data did not provide support for this hypothesis, however.

Past research points to efficiency wages as the most promising explanation of interindustry wage differentials. According to this explanation interindustry wage differentials are wage premiums which would not be observed if the labor market was functioning according to a competitive labor market model (Gera and Grenier 1994). Rationales for the efficiency wage hypothesis are provided by, among others, Akerlof and Yellen (1986) and Katz (1986). They suggest that some firms might pay a wage that is higher than the competitive wage to reduce turnover costs and shirking (see Salop 1979), to increase work effort and loyalty of employees and to attract higher quality job applicants. The implication is that firms enjoy benefits from sharing rents. These benefits may be in the form of savings associated with lower quit rates. These savings may be as high as 1 to 2 percent of labor costs (Freeman and Medoff 1984). Had the Guatemalan data set contained information on turnover (quits), an investigation of the relationship between turnover and wage premiums would help to determine whether there is presence of rents (negative relationship between turnover and industry differentials) or compensating differentials (no relationship between turnover and industry differentials). Empirical results by both Krueger and Summers (1988) and Gera and Grenier (1994) support the efficiency wages (rent-sharing) explanations.

Testing Lucas's assumption of external effects of human capital

In this section I look at the impact of human capital on wages and attempt to test Lucas's assumption of the external effects of human capital. Lucas (1988) describes how an individual's human capital investment can lead to external effects upon his co-workers by increasing their productivity and wages. Unlike most previous empirical investigations of the sources of growth (and most empirical tests of New Growth Theory), which were made using time-series and cross-section data, a two-stage microeconometric approach is used here, following Winter-Ebmer (1992).

Lucas assumes a production function involving capital, effective labor (labor adjusted for skill level) and the average level of skill, intended to capture external effects of human capital. Individuals maximize a utility function with respect to consumption and leisure. Solving the first-order conditions and following the optimality relation between capital and skill level, the real wage rate for a given skill level (the marginal product of skill) is determined.

In the first step internal effects of education are isolated using wage functions estimated using microdata, while in the second step the resulting industry wage premiums are regressed on average human capital as well as industry-specific characteristics to account for the external effects of human capital.

In filtering out internal effects to human capital a sample of workers between the ages of 18 to 65 is used to estimate an earnings function with the log of hourly wage[2] as the dependent variable, as follows (for a list of control variables, see footnote 1):

$$\log W = a_0 + a_j X_j + b_i Z_i + e$$

A problem that had to be overcome was the absence of more detailed industry classification data beyond nine highly aggregated industry categories and, therefore, the absence of sufficient data points for the second stage regressions. The solution chosen is to use occupation in order to subdivide the broad industry classifications into homogeneous categories such as professionals in manufacturing, manual workers in electricity and so on; 21 such

[2] Only income from worker's principal job is considered.

categories were created. The greater homogeneity of the resulting industry categories is an added benefit of this approach. This is because if an individual's human capital investment has external effects upon his co-workers, this is expected to occur more within a homogeneous group of workers; for example, within a group of manual workers in any given industry.

In the second step the coefficients of the industry dummies (b_i) are regressed on industry characteristics (I_k) -- including average human capital variables by industry, as follows:

$$b_i = c_0 + c_k I_k + e_{ib}$$

If the coefficients of the average human capital variables turn out to be statistically significant, then we can conclude that human capital has external effects over and above the effects on the individual.

The explanatory power of regressions with both control variables and industry dummies, only control variables and only industry dummies are shown in Table 3. Comparing the R^2 of equations 1, 2 and 3 we can conclude that industry effects explain between 1.3 and 35.3 percent of wage variation.

The coefficients of the industry dummies (wage differentials) from the full regression (column 1, table 3) with their t-statistics as well as the cell sizes for each industry category are presented in Table 4. Approximately half of the wage differentials are statistically significant or nearly statistically significant at the 5 percent level.

In the second stage I looked at external effects. If human capital has any external effects, industry wage premiums are expected to be higher in industries with average human capital. Proxies for human capital are taken to be average years of schooling and average age (or experience). No information of on-the-job training was available. Other control variables included are fraction male, fraction non-indigenous and fraction of workers in firms with less than 10 employees. Information on several other possibly relevant variables such as quit rates, industry concentration ratio and union density were not available.

Table 3: Wage Equations[a] (Dependent Variable: Log Hourly Wage)

	(1)	(2)	(3)
Control variables[b]	19	19	No
Industry Dummies[c]	20	No	20
N	6,214	6,214	6,214
R^2 (corrected)	0.60	0.587	0.353

Source: ENS 1989.

a. Weighted regressions were used.

b. For control variables used see footnote 1.

c. Industry dummies were constructed by combining the one-digit industry variable and the occupation variable for: agriculture (control category), mining, four subgroups in manufacturing (professionals, administrators, office workers and manual workers), four subgroups in electricity, gas and water (same as above), two subgroups in construction (white-collar and blue-collar workers), two subgroups in commerce (professionals and administrators, other), three subgroups in transportation (professionals, administrators and office workers, manual workers), two subgroups in finance (professional and administrators, other), and two subgroups in services (professionals and administrators, other).

Table 4: Industry Wage Differentials

		n_i
Industry 1	-	1,882
Industry 2	0.163 (1.24)	19
Industry 3	-0.004 (0.04)	50
Industry 4	-0.241 (2.06)	43
Industry 5	0.042 (0.50)	63
Industry 6	-0.164 (4.11)	841
Industry 7	0.266 (1.96)	18
Industry 8	0.154 (1.77)	45
Industry 9	0.021 (0.16)	20
Industry 10	-0.009 (0.21)	416
Industry 11	-0.083 (0.92)	79
Industry 12	-0.134 (3.12)	540
Industry 13	0.131 (1.12)	30
Industry 14	0.013 (0.27)	251
Industry 15	0.035 (0.28)	27
Industry 16	0.208 (1.66)	33
Industry 17	0.162 (2.64)	124
Industry 18	0.331 (4.35)	493
Industry 19	-0.017 (0.16)	73
Industry 20	0.128 (2.01)	175
Industry 21	-0.050 (1.28)	992
N	6,214	

Table 5: Explanation of Industry Wage Premiums*

	1	2	3	4
Constant	-0.447	-0.441	-2.128	-2.375
Average years of schooling	0.014	0.011	-0.001	-0.007
	(1.45)	(1.00)	(0.07)	(0.35)
Average age	0.012	0.014	0.014	0.019
	(0.92)	(1.05)	(1.07)	(1.26)
Fraction male				0.118
				(0.53)
Fraction non-indigenous			0.912	0.911
			(1.10)	(1.05)
Fraction in firms with less than 10 workers		-0.132		-0.120
		(0.91)		(0.80)
R^2	0.130	0.173	0.191	0.242
R^2 (corrected)	0.028	0.018	0.039	-0.029

* Following Winter-Ebmer (1992), estimated industry wage differentials have been adjusted to reflect proportional difference in wages between an employee in industry i and the average employee.

With only 20 industry categories and some variables correlated, in table 5 results for 4 different combinations of regressors are presented.

No variable in any one of the four regressions is significant at the 5 percent level. The only variable that comes close to being significant is years of schooling in equation 1. However, there is a sign reversal when the fraction non-indigenous variable is present (equations 3 and 4). The coefficient of average age is consistently positive but with a t-value of only about 1. Likewise for fraction non-indigenous and the firm size variable; coefficients enter consistently with the correct sign but significant only at the 25-30 percent level. Overall, one can go as far as finding that external effects of human capital are not rejected by the data. Given the low number of industry categories and lack of additional control variables, stronger conclusions cannot be drawn.

Finally, some overall comments are in order. Traditional growth theory is based on the work of Solow (using a neoclassical production function). In this framework, increased use of factors of production does not lead to sustainable economic growth due to diminishing returns. The only source of sustained growth is technical change, which is exogenous. Solow does not discuss it extensively, although it is supposed to be the most important component of growth. Endogenous growth models (new growth theory models) on the other hand, are questioning the assumption of diminishing returns. They in fact say that accumulation of factors of production such as labor and capital (including human capital) make the same or an increasing contribution to output as the economy becomes richer. This creates a role for governments in the growth process because in this framework increased investment in human capital would lead to faster growth.

Concerning the estimation of external effects of education I believe that the two-stage approach examined in this study which uses data at the industry level as opposed to cross-sectional data for different countries is very promising. To be able to derive clear-cut results on the existence of external effects, one needs better data rather than a better model. In particular, a finer disaggregation of industries is essential if one is to have enough data points for the second-stage regression. A richer selection of human capital variables and variables on industry characteristics is also needed. The above seem to indicate that the existence of external effects to education could be first tested using a data set from a country for which rich labor market data exist, such as the United States or Canada, or one of the World Bank-financed LSMS surveys.

ANNEX
Results of full regression

Variable	Coefficient (t-value)
Intercept	0.493 (4.1)
School	0.056 (9.5)
School square	0.0008 (2.3)
Age	0.041 (7.8)
Age square	-0.0004 (6.1)
Separated	-0.147 (5.3)
Indigenous	-0.121 (6.6)
< 10 employees	-0.344 (22.1)
Male	0.178 (9.4)
Urban	0.129 (7.5)
Industry 2	0.163 (1.24)
Industry 3	-0.004 (0.4)
Industry 4	-0.241 (2.06)
Industry 5	0.042 (0.50)
Industry 6	-0.164 (4.11)
Industry 7	0.266 (1.96)
Industry 8	0.154 (1.77)

Industry 9	0.021 (0.16)
Industry 10	-0.009 (0.21)
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Industry 17	0.162 (2.64)
Industry 18	0.331 (4.35)
Industry 19	-0.017 (0.16)
Industry 20	0.128 (2.01)
Industry 21	-0.050 (1.28)
R^2	0.60
N	6,214

Source: ENS 1989.

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